# EXPERT REPORT ON RIO GRANDE BASIN OPERATIONS

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**Table of Contents**

# 1 PURPOSE AND NEED

I have been asked by the U.S. Department of Justice to provide information relating to the operation of Amistad and Falcon International Dams and Reservoirs and the flow regime in the area downstream of Amistad International Dam. This includes the operating criteria used for making releases at the dams, how these releases are determined, the flows and depths of the river at specific points, and how the International Boundary and Water Commission (Commission) operates in this stretch of the river to meet its mission, particularly as it relates to navigation. The overall purpose of this is to describe how the flow regime of the Rio Grande has been altered over time, through development and other environmental factors, how the Commission has implemented the 1944 Water Treaty in meeting its mission, and the infrastructure the Commission has constructed as part of this treaty.

I have also been asked to provide an opinion on how the 1944 Water Treaty[1] addresses the subject of navigation, current navigational uses of the Rio Grande within the responsibility of the Commission, and how this could be prioritized in the future within the stretch of river extending from Amistad International Dam to Falcon International Dam and Reservoir. This is based on my experience working in the Water Accounting Division of the U.S. Section of the International Boundary and Water Commission (U.S. Section) as a Hydrologist while implementing the provisions of the 1944 Water Treaty.

# 2 SUMMARY OF OPINIONS EXPRESSED IN THIS REPORT

Based on my experience and knowledge of the 1944 Water Treaty, navigation is considered as an authorized use of the waters of the basin. The primary limiting factors are the current hydrology and infrastructure constructed upstream of the international reach[2] of the river and boundary, known as the limitrophe[3], and its tributaries. Under current hydrology and channel conditions navigation would be limited to smaller watercraft and is dependent on the exact

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[1] The Treaty of February 3, 1944 is the foundational agreement that dictates—for purposes beyond navigation—the management of water and creation of water control infrastructure in the international reach of the Rio Grande Basin (Rio Bravo in Mexico) for the use of these waters.

[2] Reach refers to a section or segment of a stream or river.

[3] The limitrophe refers to the international boundary reach of the international rivers which define the boundary line between the U.S. and Mexico for the Rio Grande and Colorado Rivers.

cross-section and water depths in the region being traversed. There is infrastructure like weirs and small diversion dams that would limit access at lower water levels. At higher water levels, the effects of these minor infrastructure are drowned out, making it easier to traverse the full stretch of the river. Additional infrastructure may be required to allow passage through these sections of river, depending on the size of the watercraft and destination. Within the scope of operations of the Commission, the agency deploys a wide range of watercraft throughout the river as a part of conducting normal and emergency mission operations. This includes surveillance of levees and infrastructure; collection of scientific data, flow and water level measurements, water samples; studies; and surveys. A future change in priority and operations, removal of constructed infrastructure, additional infrastructure, or river channel modifications could allow for expanded navigational access as well longer periods of navigation.

# 3 QUALIFICATIONS

I am Adrian D. Cortez, Senior Hydrologist with the U.S. Section of the International Boundary and Water Commission. I have held this position since 2018 and previously held the position of Hydrologist with the U.S. Section beginning in 2010. In this role I have been a member of the Water Accounting Division of the Operations Department and I am responsible for providing U.S. Section leadership with technical analyses and opinions regarding matters of operations of the international dams and reservoirs, application of various treaties between the United States and Mexico, and the drafting, negotiating and implementing of Minutes of the Commission that execute and clarify provisions of the 1944 Water Treaty between the United States and Mexico. My educational background is a B.S. in Civil Engineering with post-graduate work in Environmental Engineering, focusing on water treatment.

My program areas have been boundary wide and include: the Colorado River Basin and the water treaty deliveries made to Mexico within the limitrophe section of the Colorado River and international land boundary under the 1944 Water Treaty; the international reach of the Rio Grande from Fort Quitman, Texas to the Gulf of Mexico under the 1944 Water Treaty; and deliveries to Mexico on the Rio Grande in the vicinity of El Paso, Texas under the Convention of 1906. In this capacity I have worked domestically with various federal and state agencies, including the U.S. Department of Interior, Bureau of Reclamation and Geologic Survey; the National Weather Service; state agencies like the Texas Commission on Environmental Quality (TCEQ); and representatives for the seven basin states of the Colorado River.

Binationally, I work directly with counterparts in the Mexican Section of the Commission. My work includes providing technical calculations of water accounting for the Colorado River and Rio Grande; studying, developing, negotiating, and implementing Commission Minutes; developing and analyzing basin scale water operations models, and working with technical representatives at Mexico's federal water agency, the National Water Commission (CONAGUA), on these same matters.

With regards to the operations of the international reservoirs, I have worked with agency staff and the TCEQ Watermaster's Office to answer questions and resolve disputes related to the conveyance and ownership of waters in the international reach of the Rio Grande, perform binational accounting of these waters, and provide technical recommendations on the operation of the international reservoirs for the management of flood water when those conditions arise. I am also responsible for administering the database systems that store agency water quantity data, precipitation, water levels, near-real time information and the development of the data portals and products for transmittal to internal and external customers. I have also been responsible for the QA/QC of this data to ensure accuracy of the record for use in operations, studies, and water accounting.

With regards to hydrologic duties I have performed analyses and studies of various reaches of the Rio Grande, Colorado, and Tijuana River systems to support decision making and operational guidance. I have performed statistical analyses and review of the long-term trends of these watersheds, focusing on the Rio Grande, and serve as one of the technical experts reporting this information to both sections of the Commission, external technical representatives in both countries, and a wider group of stakeholders.

I have not previously provided an expert report or testimony in the last five years. I have not authored any publications in the last 10 years. A recent Curriculum Vitae (C.V) is attached as Exhibit A.

# 4 RIO GRANDE BASIN OVERVIEW

The Rio Grande Basin is regulated by different administrative and legislative frameworks within the United States and Mexico that have been negotiated and executed to allocate all the waters of this basin. These include, for example, the Rio Grande Compact of 1938 and the Pecos River Compact that distribute waters of the Rio Grande and the Pecos River (one if its largest tributaries) in the headwaters of the basin; federally administrated programs like the Rio Grande Project, that distribute waters to users nears El Paso, Texas; and rules and regulations that are formed and executed by individual states to provide beneficial use of those waters, including municipal, irrigation, recreation, environmental protection, navigation, and power generation. The Rio Grande basin is also subject to international agreements that distribute and allocate the waters of Rio Grande, and its tributaries between the countries of the United States and Mexico.

To capture and store the flow of the river and implement these agreements from year to year, the flow regime of the Rio Grande has been highly altered by the construction of reservoirs and diversion structures from the headwaters in southern Colorado to its mouth at the Gulf of Mexico, where the Rio Grande empties. Portions of the river, at present, often go dry as the river has become disconnected from its headwaters. The water conveyance infrastructure upstream of El Paso, Texas is operated to maximize beneficial use of these waters for the local region and limit the flows passing downstream. The flow regime of the Rio Grande near El Paso, Texas is determined by irrigator demand and the growing season.

As shown in the following plot, it is normal for the flow registered at the stream gage, Rio Grande at El Paso, Texas, to drop below 100 cubic feet per second during the winter and early spring. Flow during this period is primarily sourced from irrigation drains and nearby treatment plants. When making releases from dams in the spring and summer, these releases are limited to only what is necessary for irrigation and other water right holders.

This water management structure results in a basin that is split in two. The hydrology of the upper basin is primarily driven by snowpack and the resulting spring snowmelt in the head waters, while the lower basin obtains most of its water from monsoons and tropical systems in the spring and summer. Due to this distinct basin feature, I will focus mostly on the flow regime of the river downstream of Fort Quitman, Texas, as this is the main division point on the river that divides the provisions of the 1944 Water Treaty from the Convention of 1906 and delineates the two operational river regimes.

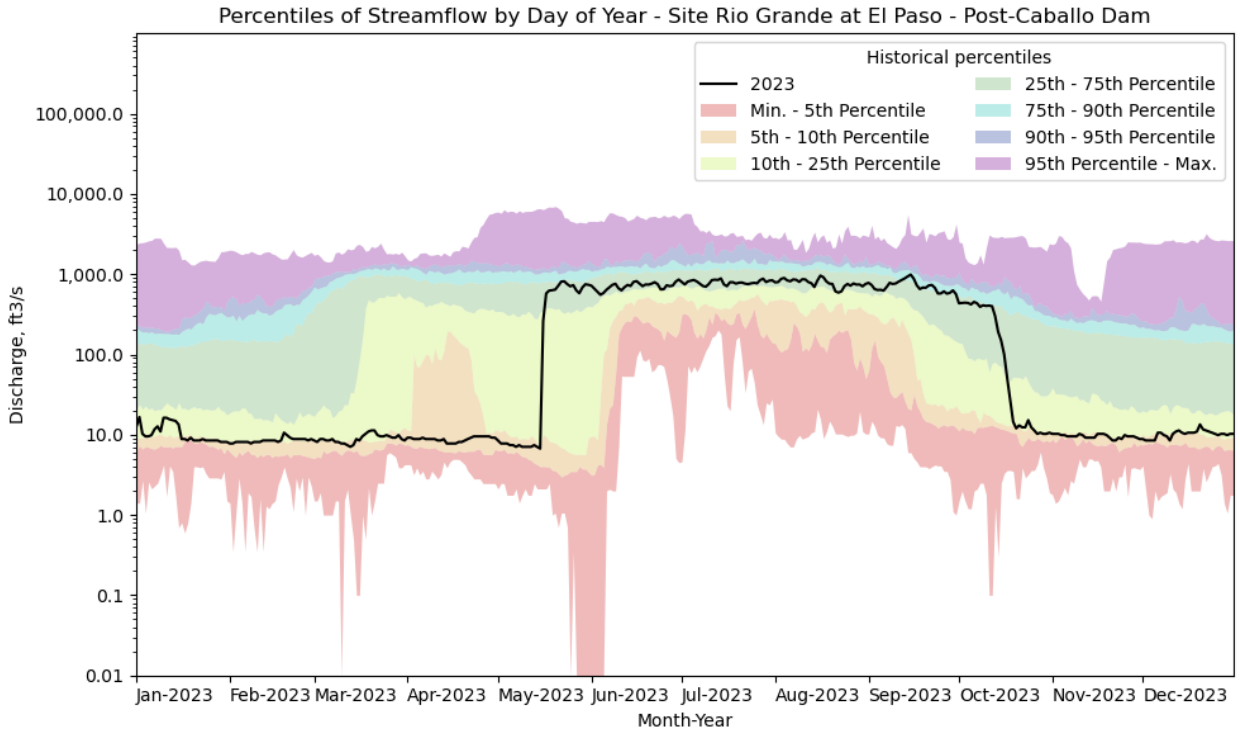


FIGURE 1 - RIO GRANDE AT EL PASO, TEXAS: FLOW REGIME AFTER CONSTRUCTION OF CABALLO DAM

This international reach of the Rio Grande is the subject of boundary treaties and water treaties which define the international boundary, the ownership of waters in the international reach, and water delivery requirements at different points along the river. For the matters addressed by the 1944 Water Treaty, it also serves as the framework for resolving disputes between the two countries, subject to approval of the two Governments[4]. The Treaties are administered by the International Boundary and Water Commission through the United States and Mexican Sections, each of which operates within the jurisdiction of their respective countries.

## 4.1 SELECTED DAMS OF THE RIO GRANDE WATERSHED

**Elephant Butte – Approximate Construction Date - 1915:**
Storage Dam on the Rio Grande located north of El Paso, Texas near Truth or Consequences, New Mexico. Owned and operated by the U.S. Department of Interior, Bureau of Reclamation for the Rio Grande Project, it is the main storage dam for deliveries to the United States and Mexico in the vicinity of El Paso, Texas. It also acts a flood control dam for the Rio Grande Canalization Project.

[4] 1944 Water Treaty - Article 24 (d)

**Caballo – Approximate Construction Date - 1938**:
Storage Dam on the Rio Grande located north of El Paso, Texas near Truth or Consequences, New Mexico, and downstream of Elephant Butte. Owned and operated by the U.S. Department of Interior, Bureau of Reclamation for the Rio Grande Project, it is operated as a regulating and storage dam for deliveries to the United States and Mexico in the vicinity of El Paso, Texas. It also acts a flood control dam for the Rio Grande Canalization Project.

**Red Bluff – Approximate Construction Date - 1936**:
Storage Dam on the Pecos River, a tributary of the Rio Grande, located in Texas near the border between Texas and New Mexico, south of Carlsbad, New Mexico and north of Pecos, Texas.

**Boquilla – Approximate Construction Date - 1916:**
Storage Dam on the Rio Conchos, a tributary of the Rio Grande, located near Cuidad Carmago, Chihuahua, Mexico. The largest of the storage dams on the Rio Conchos, it provides flood protection and water for irrigation and other uses in the local region.

**Luis L. Leon – Approximate Construction Date - 1968**:
Storage Dam on the Rio Conchos, a tributary of the Rio Grande, located near Presidio, Texas and Ojinaga, Chihuahua, Mexico, a region in Texas commonly referred to as Big Bend. It is the last flood storage and conservation dam on the Rio Conchos, it provides flood protection to the binational cities, and water for irrigation and other uses in the local region.

**Venustiano Carranza – Approximate Construction Date - 1930**:
Storage Dam on the Rio Salado, a tributary of the Rio Grande, located near Juarez, Coahuila, Mexico. It is colloquially referred to as Don Martín. The largest of the storage dams on the Rio Salado, it provides flood protection and water for irrigation and other uses in the local region. This tributary empties directly into Falcon International Reservoir.

**Amistad – Approximate Construction Date - 1968:**
International storage dam located in the limitrophe of the Rio Grande, near Del Rio, Texas and Cuidad Acuña, Coahuila, Mexico. It is operated jointly by the U.S. and Mexican Sections of the International Boundary and Water Commission.

**Falcon – Approximate Construction Date - 1953:**
International storage dam located in the limitrophe of the Rio Grande, near Falcon Heights, Texas and Nueva Ciudad Guerrero, Tamaulipas, Mexico. It is operated jointly by the U.S. and Mexican Sections of the International Boundary and Water Commission

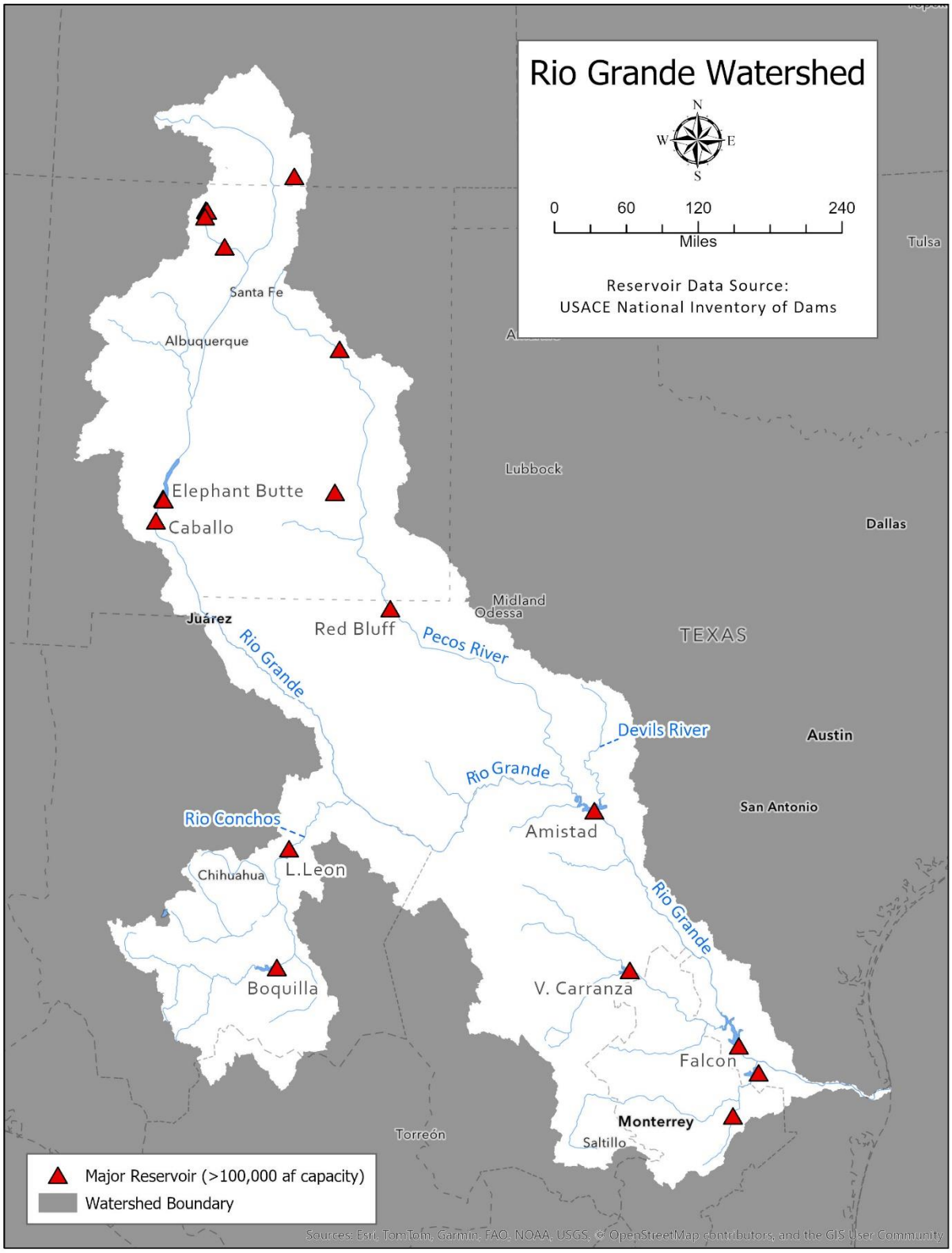


FIGURE 2 - RIO GRANDE WATERSHED AND SELECTED DAMS (>100,000 AC-FT CONSERVATION CAPACITY)

## 4.2 1944 WATER TREATY – OVERVIEW

The 1944 Water Treaty for the "Utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande" distributes the waters on the Rio Grande and Colorado Rivers between the United States of America and Mexico, establishes flood control projects for these watersheds, and acknowledges the need for future agreements in other binational watersheds in the western portions of the countries, not already established under the 1944 Water Treaty. The treaty also establishes the administrative protocols that govern the International Boundary and Water Commission. This entity previously operated as the International Boundary Commission (IBC) as established pursuant to the 1889 Convention between the United States and Mexico. Under the 1944 Water Treaty the Commission assumed the duties and powers vested to the IBC, as well as new duties and responsibilities as spelled out under said Treaty. This treaty was ratified by the governments of both countries and entered into force on November 9, 1945.

## 4.3 PROVISIONS OF THE 1944 WATER TREATY APPLICABLE TO WATER CONTROL AND USE

The 1944 Water Treaty establishes the jurisdiction of the Commission to the limitrophe parts of the Rio Grande and Colorado Rivers, and the land boundary between the two countries, as well as any works[5] located upon the boundary.[6]

The Water Treaty also establishes the priority order for the use of international waters in the following order[7] as specified in Article 3 of the 1944 Water Treaty:

1. Domestic and Municipal uses.
2. Agriculture and stock raising
3. Electric Power
4. Other industrial uses
5. Navigation
6. Fishing and Hunting
7. Any other beneficial uses which may be determined by the Commission.

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[5] Works refers to the structures authorized by the 1944 Water Treaty for construction and operations and any other structures required, as approved by the two Governments.

[6] 1944 Water Treaty – Article2

[7] 1944 Water Treaty – Article 3

As it relates to the Rio Grande Basin, the Water Treaty allots the division of water between the two countries so that (at that time) the water arriving at the mainstem of the international reach of the Rio Grande would be split, and made available for beneficial use, about equally between the two countries. This roughly equal split was accomplished by allotting to the U.S. all the flows arriving at the main stem of the Rio Grande from seven tributaries originating in the U.S., and one third of the flows arriving from six tributaries originating in Mexico. To Mexico were allotted two thirds of the flow arriving at the mainstem from the aforementioned six-named tributaries in Mexico and 100% of the flow from two other Mexican tributaries. Any other flows arriving in the mainstem, not already accounted for as described above, would be split evenly between the two countries.[8]

**Allotted Tributaries of the Rio Grande under the 1944 Water Treaty:**

- Tributaries Allotted to the United States in the International Reach:
    - Pecos River
    - Devils River
    - Terlingua, Alamito, Pinto, San Felipe Creeks
    - Goodenough Springs
    - One-Third of Flow Arriving at the Rio Grande from Mexican Tributaries:
        - Rio Conchos
        - Arroyo de las Vacas
        - Rio San Diego
        - Rio San Rodrigo
        - Rio Escondido
        - Rio Salado
    - One-Half of Any Unmeasured Tributaries or Other Flows Not Allotted
- Tributaries Allotted to Mexico in the International Reach:
    - Two-Thirds of the Flows Arriving at the Rio Grande from Mexican Tributaries:
        - Rio Conchos
        - Arroyo de las Vacas
        - Rio San Diego
        - Rio San Rodrigo
        - Rio Escondido
        - Rio Salado
    - Rio Alamo and Rio San Juan
    - One-Half of Any Unmeasured Tributaries or Other Flows Not Allotted

[8] 1944 Water Treaty Article 4

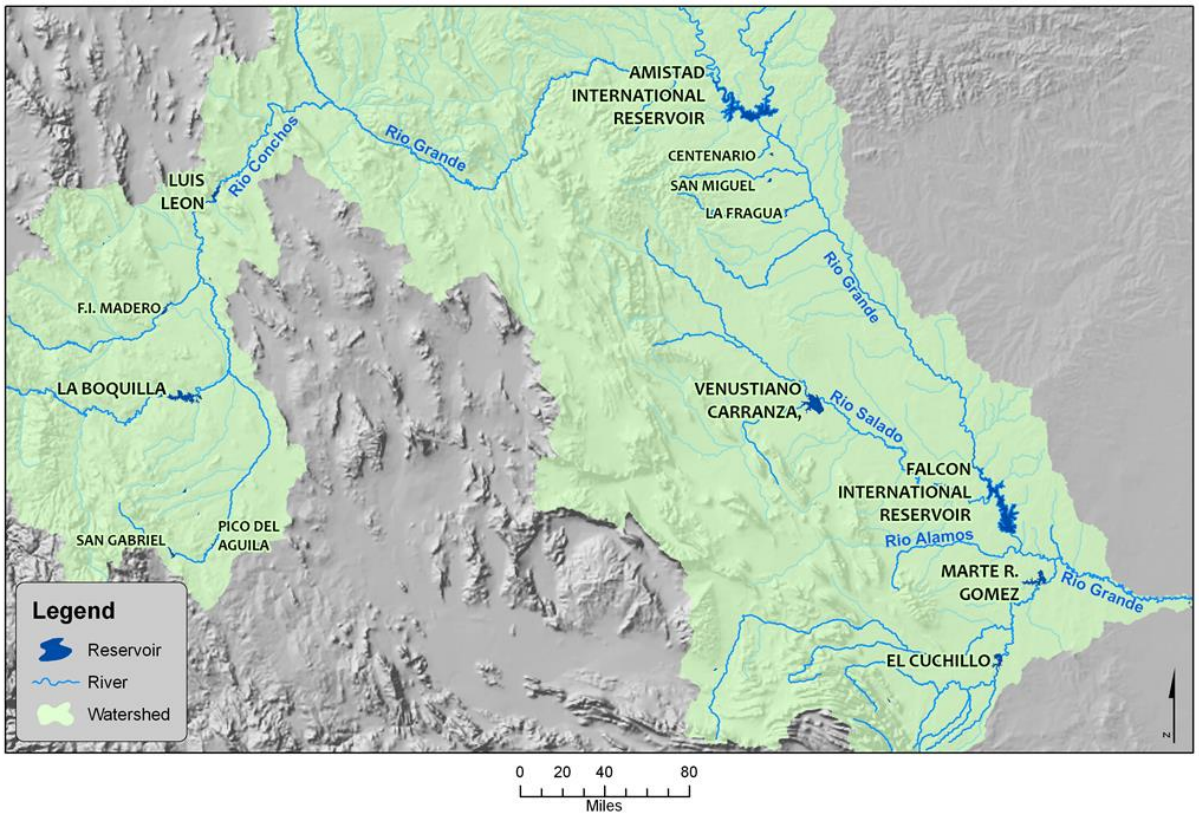


FIGURE 3 - IMPORTANT DAMS AND TRIBUTARIES OF THE INTERNATIONAL REACH OF THE RIO GRANDE BASIN

To allow for the "…conservation, storage and regulation of the greatest quantity of the annual flow of the river in a way to ensure the continuance of existing uses and the development of the greatest number of feasible projects, within the limits imposed by the water allotments…"[9], the 1944 Water Treaty authorizes the construction of up to three storage dams that would be located in the international reach of the Rio Grande. Of the three storage dams authorized, only two were constructed, Amistad International Dam and Falcon International Dam, which will be described in greater detail later in this document. The 1944 Water Treaty specifies ownership of these volumes with reference to various portions thereof, termed "conservation storage; "silt storage"; and "flood control storage." "Conservation storage" is the useable portion of the impounded waters that can be called upon for beneficial use downstream. Usable in this usage meaning the volume of water that can be passed through the dam, by gravity, out of its outlet works. "Silt storage" refers to the volume of water that remains behind

[9] 1944 Water Treaty Article 5.I

the dam, below the lowest outlet work, which cannot be released downstream by gravity, or the portion of dam that has filled in with sediment after its construction. "Flood control storage" refers to the volume of water that the dam can impound above its conservation storage and exists to store and attenuate flood waters for safer passage downstream. The Water Treaty provides that ownership of the conservation storages and silt storage for these dams shall be divided in proportion to each countries' requirements and needs in order to meet its current and future needs and taking into account the flow regime of the basin from year to year. For flood control, "each country shall have an undivided interest"[10] meaning neither country can own any volume of water residing in flood storage.

The Water Treaty also establishes guidelines regarding the operation of water control infrastructure. To this point, any international reservoirs constructed above the lowest are said to be maintained at the maximum possible water level, consistent with flood control, irrigation use, and power requirements. The Water Treaty established rules on the ownership of inflows, and the discharge of any flood waters, and the assignment of losses. Under normal conditions, "either of the two countries may avail itself, whenever it so desires, of any water belonging to it, and stored in the international reservoirs, provided that the water so taken is for direct beneficial use or for storage in other reservoirs."[11]

For the purpose of using the water allotted to each country, either country may convey these waters through the Rio Grande channel and construct any necessary works to divert their waters, assuming water is available to make said diversion. Any consumptive use is charged against the country making the withdrawal. Either country is also permitted, as authorized by the Commission, to temporarily divert or use water belonging to the other country, if this can be done without injury to the other country and said waters can be replaced at another point on the river. The Commission can also authorize the use of waters not belonging to a country, without replacement, if the other country cannot use or does not need such waters. Diversion in that manner does not establish a right to these waters for future diversion. For the purposes of generating hydroelectric power, either country may divert any amount of water provided that this diversion does not cause injury to the other country and does not interfere with the international generation of power and any losses are charged against the country making the diversion. To track and keep a complete record of the waters belonging to either country at any given moment, the Commission and each Section of the Commission is required to construct, operate, and maintain on the main channel of the Rio Grande, and its respective tributaries all

[10] 1944 Water Treaty Article 5

[11] 1944 Water Treaty Article 8

gaging stations and mechanical apparatus (e.g., hydraulic control structures) to collect the necessary data to maintain this record.[12]

# 5 IMPORTANT INFRASTRUCTURE – INTERNATIONAL REACH OF RIO GRANDE BASIN

Pursuant to the 1944 Water Treaty two international storage dams were constructed to allow for the storage of international waters as well as allow for the regulation of flood waters[13]. While the 1944 Water Treaty authorized construction of three storage dams,[14] two dams were carried forward for design and construction. The process for this was documented under Minutes of the Commission which described the joint studies and designs that took place for establishing the placement, the engineering criteria and details, the division of construction and maintenance costs, and rules for operation. Design and construction of the two dams were performed consecutively. The first dam to be designed and constructed was Falcon International Dam, located the farthest downstream. Amistad International Dam, the largest and located upstream of Falcon, began design and construction once Falcon was largely complete and placed into operation. For purposes of this report, focus will be placed on Amistad International Dam, as it is the controlling structure for the flow regime for the section of river within the report boundaries.

## 5.1 GAGING STATIONS OPERATED BY THE COMMISSION

The Water Treaty, per Article 9 (j), requires the Commission to "…keep a record of the waters belonging to each country and of those that may be available at a given moment…" and authorizes the construction of gaging stations on the Rio Grande and its tributaries in order to meet this requirement. In implementing the Water Treaty and this provision, the Commission operates over 60 river gages on the Rio Grande and its tributaries which are used as input points for determining the ownership of waters in 14 river reaches extending from Fort Quitman, Texas to the Gulf of Mexico. Additionally for the purposes flood monitoring and operational decision support, the Commission operates an additional 35+ river gages on

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[12] 1944 Water Treaty – Article 9

[13] Per Article 5 of the 1944 Water Treaty "Each country shall have an undivided interest in the flood control capacity of each reservoir"

[14] 1944 Water Treaty – Article 5

contributing arroyos, streams, and tributaries, and additional points on the mainstem near urban areas, or regions of operational concern. All these gages are part of near-real-time telemetry network operated and maintained by both Sections of the Commission in order to provide operational decision support and up-to-date information for partner agencies, stakeholders, and the public at large.

## 5.2 AMISTAD INTERNATIONAL DAM AND RESERVOIR – GENERAL DESCRIPTION[15]

Constructed from 1964 to 1969, Amistad Dam was the second of two international multi-purpose storage dams constructed on the international reach of the Rio Grande, pursuant to the 1944 Water Treaty. Amistad Dam and Reservoir is used for flood control, conservation and water supply, recreation, and power generation to the benefit of users in the United States and Mexico. Amistad Dam is located approximately 12.8 river miles upstream of Del Rio, Texas in the United States and Ciudad Acuña, Coahuila in Mexico at river mile 573.9. Impoundment of water behind Amistad Dam and the forming of Amistad Reservoir began on May 31, 1968, prior to completion of the construction activities in June of 1969. Major tributaries that flow into Amistad Reservoir are the Pecos and Devils Rivers in the United States, whose mouths were inundated by the formation of Amistad Reservoir, and the Rio Conchos in Mexico which enters the mainstem of the Rio Grande at river mile 961.4, or approximately 388 river miles upstream. The Rio Conchos is the largest of the Mexican tributaries that arrive at the Rio Grande.

FIGURE 4 - AMISTAD DAM AND INTERNATIONAL RESERVOIR (LOOKING UPSTREAM)

[15] Technical Summaries of Projects Along the International Boundary – United States and Mexico – Amistad Dam Project, dated March 17, 2000.

The construction and operating rules of Amistad Dam were executed by Minutes of the Commission pursuant to the 1944 Water Treaty and under U.S. law by, Act of July 7, 1960, Public Law 86-605, 74 Stat. 360, 22 U.S.C. § 277D-13-16:

- Min. No. 207, dated June 1, 1958, "Consideration of Joint Report of the Principal Engineers on Site, Capacities and Type of Dam for the Second Major International Storage Dam on the Rio Grande"
- Min. No. 210, dated January 12, 1961, "Recommendation Regarding Construction of Amistad Dam"
- Min. No. 215, dated September 28, 1963, "Design and Procedures for Construction of Amistad Dam"
- Min. No. 235, dated December 3, 1969, "Division of Operation and Maintenance Costs of Amistad Dam"

Amistad Dam is a concrete, gravity structure, with gated spillway[16], and is flanked by approximately 6.07 miles of earth embankment on either side. The most recent topo-bathymetric survey[17] was conducted in 2014, the results of which are detailed in Table 1. At present it has a total conservation capacity of 3,193,985 acre-feet, a flood storage capacity of 1,682,729 acre-feet, and super storage capacity of 393,692 acre-feet. As is documented in Minute No. 207, the conservation capacities of the reservoir were split 56.2% to the United States and 43.8% to Mexico.

[16] For Amistad International Dam the spillway is the sloped concrete face of the dam used to convey water sitting at higher elevations behind the dam, and critical to the controlled release of flood waters.

[17] Topo-bathymetric surveys are topographic maps of the physical land surface that can be inundated with water by a dam at a full range of water surface elevations, ranging from the original elevation of the river, prior to construction, to the highest point of the dam structure itself. Based on these maps and elevations, calculations for the corresponding volume and surface area are made. This information is necessary to calculate how much water exists in the reservoir, to estimate the amount of evaporation loss, or to perform other studies. Periodic surveys are conducted to calculate the amount of sediment that enters the reservoir over time, estimate the remaining useful life of the dam, and update water availability figures.

TABLE 1 - AMISTAD DAM ELEVATIONS AND STORAGE CAPACITIES (TOTAL U.S. & MEXICO)

| Amistad Reservoir | Elevation[18] (ft msl) | 2014 Survey Capacity (acre-feet) | Amistad Pool Types | 2014 Survey Capacity (acre-feet) |
|---|---|---|---|---|
| **Original River Bed** | 898 | 0 | | |
| | --- | --- | **Silt and Dead** | 32,719 |
| **Lowest Available Outlet** | 930 | 32,719 | --- | --- |
| **(Mx Outlet Works)** | --- | --- | **Usable Storage** | 3,193,985 |
| **Top of Conservation** | 1117 | 3,226,704 | --- | --- |
| | --- | --- | **Ordinary Flood** | 1,682,729 |
| **Top of Spillway Gates** | 1140.4 | 4,909,433 | --- | --- |
| | --- | --- | **Super Flood** | 393,692 |
| **Maximum Water Surface** | 1145.1 | 5,303,125 | | |

The earth embankment portion of the dam has a maximum height of 122 feet. The concrete portion of Amistad Dam consists of 40 monoliths and a stilling basin, has a height of 254 feet above the riverbed, and is 2,182 feet long. The spillway portion of the dam consists of 16 spillway gates and bays. Each spillway bay has a Tainter[19] gate that is 50 feet wide by 53 feet high, with a total combined maximum design discharge capacity of 1,507,000 cubic feet per second, at an elevation of 1145.1 feet.

[18] Described elevations are heights above mean sea level on the National Geodetic Vertical Datum of 1929 (NGVD29)

[19] A Tainter gate is a type of radial gate used in dams and other water control infrastructure for regulating the flow of water. In the case of Amistad Dam, these radial gates are used to regulate the flow of water over the spillway whenever the water surface elevation exceeds 1140.4 feet above MSL NGVD29

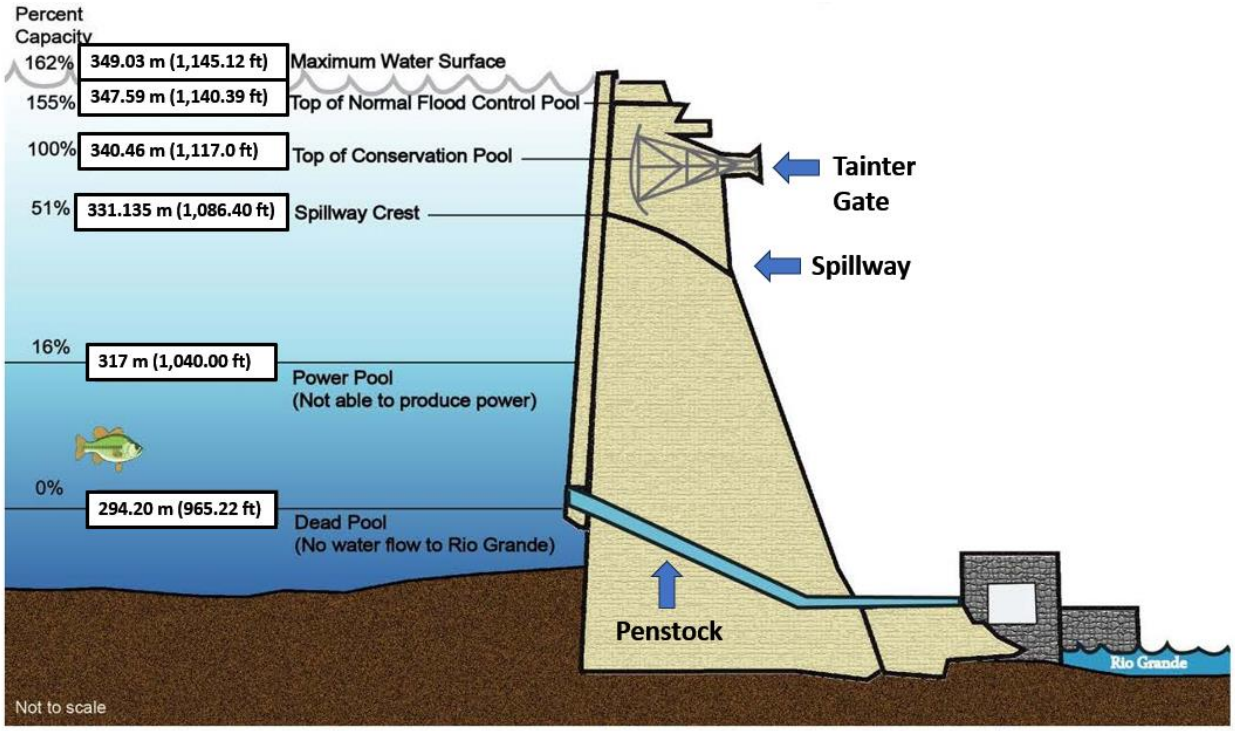


FIGURE 5 - GENERAL PROFILE VIEW OF AMISTAD DAM AND CRITICAL OPERATING ELEVATIONS

## 5.3 AMISTAD DAM – OUTLET WORKS

For the movement of water downstream to the mainstem of the Rio Grande, Amistad Dam is composed of a total of 9 penstocks[20], 5 in the United States and 4 in Mexico. On the U.S. side two penstocks are connected to power generating units, each with a generating capacity of 33,000 kilowatts. A third penstock, reserved for generating purposes, is currently plugged since construction. Two gated irrigation penstocks on the U.S. side are currently inoperable, with one planned for repair and the second likely to be permanently plugged. On the Mexico side, 2 penstocks are connected to power generating units of similar capacity as the United States, and one valved irrigation penstock.

[20] Penstocks are water conveyance features of the dam that allow the passage of water from the reservoir to the river. Various types of gates and valves are used to control flow of water through the dam. The penstocks are the primary source of water for the movement of water downstream.

FIGURE 6 - SPILLWAY RELEASE OF FLOOD WATERS FROM AMISTAD DAM

Typically, the penstocks connected to generating units are utilized for the release of water to the Rio Grande, with the irrigation penstock in Mexico being used at various times when demand is low, when efficiency prevents operation of the generating turbines, or when power generating units are undergoing maintenance. In total, approximately 7,000 to 8,400 cubic feet per second can be conveyed downstream through operation of these generating units, depending on the water surface elevation in storage. When required, the irrigation valve in Mexico can convey up-to 5,300 cubic feet per second, depending on the water surface elevation in storage. When operational, the U.S. irrigation gate can convey up-to 1,950 cubic feet per second. Combined these structures can convey up-to 7,600 cubic feet per second, depending on water surface elevation. It should also be noted that the Mexican penstocks are higher than the U.S. penstocks at 965.22 feet and 930.00 feet, respectively, further limiting out flow capacity at the lowest water surface elevations.

When required due to flood releases of volumes above the established conservation pool, or when downstream demand allows, volumes sitting above the spillway at elevation 1,086.40 feet can be released through the Tainter radial gates.

## 5.4 AMISTAD DAM – OPERATION

Inflows into the reservoir are measured and allocated pursuant to the allocation of these waters by the Water Treaty. Either country may utilize the waters owned by that country for beneficial use or release downstream to Falcon International Dam and Reservoir. Releases of waters owned by the United States are at the discretion of the Rio Grande Watermaster of

TCEQ. The control of waters in the United States' portion of the conservation storage was granted to the state of Texas under 22 U.S.C. § 277d–15. The Rio Grande Watermaster, per 30 Texas Administrative Code Chapter 303, Operation of the Rio Grande, is authorized to allocate water to user accounts in Texas who call upon the water in accordance with the rules and procedures documented therein. The Rio Grande Watermaster is authorized to call for water to be release from Amistad Dam by communicating to the U.S. Section a requested release rate. Likewise in Mexico, the National Water Commission of Mexico (CONAGUA) allocates waters to its users through their own domestic regulations and coordinates the release and beneficial use of said waters through its user associations, irrigation districts, and municipal supply accounts.

The U.S. Section and Mexican Section of the Commission each independently coordinate and execute the releases as requested by TCEQ, CONAGUA, and their respective user groups. Release of floodwaters, that is volumes above the designated total conservation elevation and storage capacity, are the joint responsibility of both sections of the Commission[21]. Both Sections of the Commission are also jointly responsible for determining the ownership of water by each country through established preliminary and final accounting procedures used to determine ownership of all waters in the international reach of the Rio Grande downstream of Fort Quitman, Texas to the Gulf of Mexico. These preliminary and final accounting calculations are performed on a weekly and monthly basis, respectively, and are used by TCEQ and CONAGUA to determine the allocation of water to their respective users.

## 5.5 FALCON INTERNATIONAL DAM AND RESERVOIR – GENERAL DESCRIPTION[22]

Falcon Dam and Reservoir began construction in December 1950 and was completed in April 1954. It is the first built and most downstream of the two international multi-purpose storage dams constructed on the limitrophe of the Rio Grande, pursuant to the Water Treaty. It is used for the purposes of flood control, water conservation, recreation, and hydroelectric power generation to the benefit of users in the United States and Mexico. Falcon Dam is located approximately 86 river miles downstream from Laredo, Texas in Starr and Zapata Counties in Texas and the State of Tamaulipas in Mexico, and approximately 270.5 river miles upstream of the Gulf of Mexico. It is located near Falcon Heights, Texas and Nueva Ciudad Guerrero, Tamaulipas, Mexico. The impoundment of Falcon Dam began on August 25, 1953[23] forming

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[21] Public Law 605, 86th Congress, approved July 7, 1960 and Minute No. 235, dated December 3, 1969, "Division of Operation and Maintenance Costs of Amistad Dam"

[22] Technical Summaries of Projects Along the International Boundary – United States and Mexico – Falcon Dam and Reservoir Project, dated March 17, 2000.

[23] Water Bulletin Number 23 - Flow of the Rio Grande and Related Data - 1953

Falcon International Reservoir, prior to final completion of the dam in 1954. A major tributary in Mexico, the Rio Salado, flows directly into Falcon Reservoir and is the second largest of the Mexican tributaries arriving in the Rio Grande.

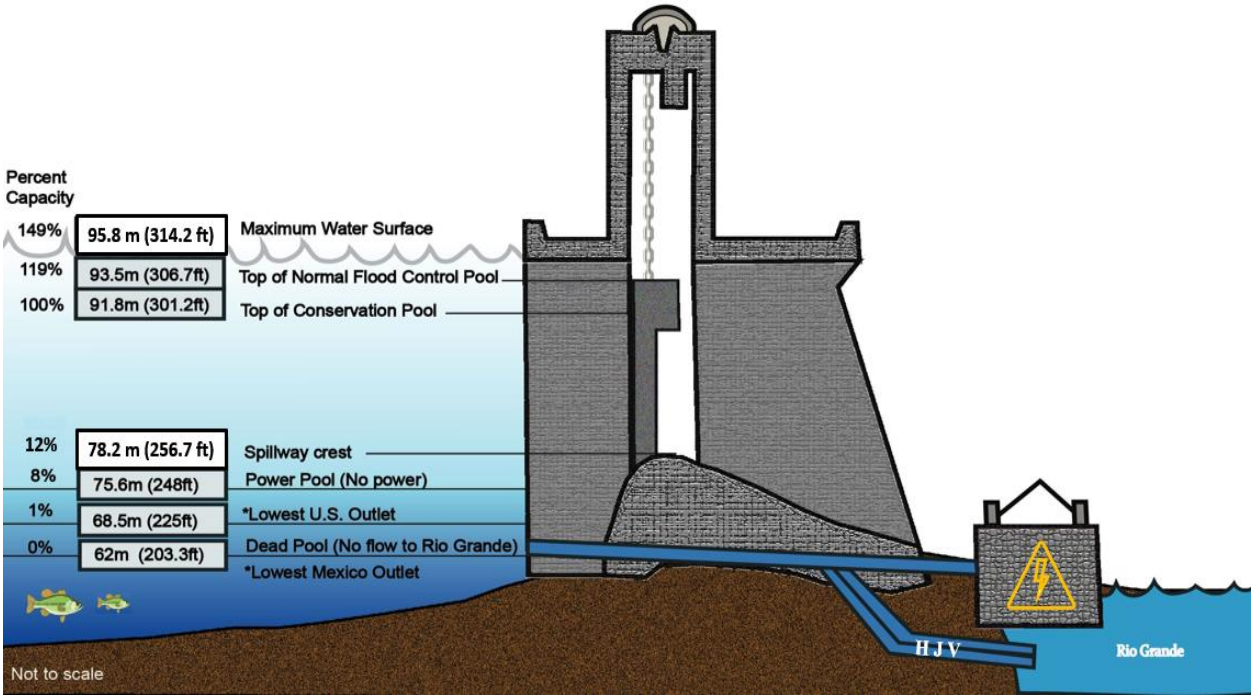


FIGURE 7 - GENERAL PROFILE VIEW OF FALCON DAM AND CRITICAL OPERATING ELEVATIONS

The construction and operating rules of Falcon Dam were executed by Minutes of the Commission pursuant to the 1944 Water Treaty and under U.S. law by, Public Law 312, Chapter 593, 63 Stat 7.01, approved October 5, 1949; Public Law 786, Chapter 948, 64 Sat 846; American-Mexican Treaty Act of 1950, 22 U.S.C. § 277D-1-9:

- Min. No. 182, dated September 23, 1946, "Approval of Joint Report on Engineering Conference on Studies, Investigations, and Procedures for the Planning of Works to be Built in accordance with the Treaty of February 3, 1944"

- Min. No. 187, dated December 20, 1947, "Determinations as to the Site and Required Capacities of the Lowest International Storage Dam to be Built on the Rio Grande, in Accordance with the Provisions of Article 5 of the Treaty Concluded February 3, 1944"

- Min. No. 190, dated August 13, 1948, "Allocation to the Two Sections of the Commission of Remaining Items of Work Preparatory to Construction of Falcon Dam"

- Min. No. 192, dated September 7, 1949, "Plans and Procedures for Construction of Falcon Dam and Recommendations for Construction of Falcon Hydro-Electric Plants"

- Min. No. 199, dated December 15, 1953, "Establishment of Jurisdictional Line in Falcon Reservoir"

- Min. No. 202, dated January 11, 1955, "Bases for Joint Operation and Maintenance of the Falcon Dam and Hydroelectric Plant and for Division of Costs Thereof"

Falcon Dam is a rolled earth-fill embankment with a chute-type gated spillway located on the United States side of the dam. It has a crest elevation of 323 feet above msl (NGVD29) and sits about 150 feet above the original riverbed. The spillway control structure has a concrete crest elevation of 256.7 feet and is controlled by six 50' by 50' fixed wheel gates. The maximum discharge capacity of the spillway at the maximum design flood reservoir level of 314.2 feet is 456,000 cubic feet per second. The Dam had two identical powerhouses, one each in the United States and Mexico, each with 3 power generating units. The most recent topo-bathymetric survey was conducted in 2014, the results of which are detailed in Table 2. At present Falcon has a usable conservation capacity of 2,666,193 acre-feet, a flood storage capacity of 514,473 acre-feet, and a super storage capacity of 807,255 acre-feet. The conservation capacities of the reservoir are split 58.6% to the United States and 41.4% to Mexico.

TABLE 2 - FALCON DAM ELEVATIONS AND STORAGE CAPACITIES (TOTAL U.S. & MEXICO)

| Falcon Reservoir | Elevation (ft msl) | 2014 Survey Capacity (acre-feet) | Falcon Pool Types | 2014 Survey Capacity (acre-feet) |
|---|---|---|---|---|
| **Original River Bed** | 175.0 | 0 | | |
| | --- | --- | **Silt and Dead** | 10 |
| **Lowest Available Outlet** | 203.33 | 10 | --- | --- |
| | --- | --- | **Usable Storage** | 2,666,193 |
| **Top of Conservation** | 301.2 | 2,666,203 | --- | --- |
| | --- | --- | **Ordinary Flood** | 514,473 |
| **Top of Spillway Gates** | 306.7 | 3,180,676 | --- | --- |
| | --- | --- | **Super Flood** | 807,255 |
| **Maximum Water Surface** | 314.2 | 3,987,931 | | |

# 6 FLOW REGIME IN THE VICINITY OF EL PASO, TEXAS FOR THE PERIOD EARLY TO MID-1900S TO PRESENT

For the stretch of the Rio Grande upstream of El Paso, Texas, the development of the Reclamation Act of 1902 and the Rio Grande Project in the early 1900s led to the completion of Elephant Butte Dam and Reservoir and the smaller Caballo Dam and Reservoir, both located near Truth or Consequences, New Mexico. Completion of these projects drastically changed the watershed, in that thereafter much of the snowpack that falls in the headwaters of the Rio Grande in the states of Colorado and New Mexico was impounded by these two dams as well as dams constructed further upstream that are operated as part of the Rio Grande Compact of 1938. The Rio Grande Project is programmatically administered by the U.S. Department of Interior Bureau of Reclamation and provides water for irrigation, flood control, power generation, municipal and industrial use in southern New Mexico and West Texas.

This Project also serves as the water source for implementing the Convention of 1906, which allotted a maximum of 60,000 acre-feet of water to Mexico annually for delivery to an irrigation canal near Cuidad Juarez, Chihuahua, Mexico. Under the current infrastructure topology, the Commission operates two diversion dams in El Paso, Texas, American Dam, and International Dam, which are used to divert water into U.S. and Mexican canals, respectively. Water for the U.S. and Mexico were both diverted at International Dam into canals, one in the U.S. and one in Mexico, prior to construction of American Dam and American Canal in 1938. Releases were also made downstream of International Dam for diversion by the U.S. at Riverside Dam, until American Canal was further extended to service U.S. users in El Paso's Lower Valley[24]. Riverside Dam was no longer operated after extension of American Canal in the 1990s. Users in the region include U.S. irrigation users like the Elephant Butte Irrigation District, the El Paso County Water Improvement District No.1; various U.S. municipalities; and Irrigation District 009 in Mexico. The two reservoirs also hold waters from the Colorado River, which is conveyed through an inter-basin transfer to the Rio Grande via the Rio San Juan-Chama Project.

Under normal operating conditions, water releases downstream of American Dam are primarily for diversion at International Dam into Mexico's main irrigation canal, the Acequia Madre, volumes allotted under the Convention of 1906. Flows below International Dam in the mainstem of the Rio Grande generally only occur when excess drainage downstream of Caballo

[24] Technical Summaries of Projects Along the International Boundary – United States and Mexico – Rio Grande American Canal Extension Project, dated March 17, 2000

Dam and upstream of International Dam cannot be diverted into the canals or off-channel storage, or from stormwater, arroyo flow, or drainage returns entering the main channel of the Rio Grande in the rectification reach[25] downstream of International Dam. Historically there are rare instance that flood waters from Elephant Butte and Caballo originating from the upstream watershed must be conveyed downstream. The portion of the Rio Grande downstream of Fort Quitman, Texas, to the region near Presidio, Texas, is often referred to as the Forgotten Reach, as any water that passes the stream gage at Fort Quitman, Texas often disappears before reaching Presidio, Texas. On average 130,000 acre-feet pass the Fort Quitman stream gage annually for the period 1938 to 2023. The next major tributary that supplies water to the Rio Grande is the Rio Conchos, which is described in the following section, which originates in Mexico and flows north, arriving at the Rio Grande near Presidio, Texas in the U.S. and Ojinaga, Chihuahua in Mexico.

# 7 FLOW REGIME PRIOR TO COMPLETION OF AMISTAD INTERNATIONAL DAM

The Rio Conchos is the main tributary that provides water to the Rio Grande upstream of Amistad Dam and the Rio Conchos enters the Rio Grande at river mile 961.4, just upstream of Presidio, Texas and Ojinaga, Chihuahua, Mexico. For the period between 1900 and 1945, flows from this tributary averaged roughly 1,400 cubic feet per second or 1,000,000 acre-feet annually.

For analyses of the flow regime in the reach between the two international reservoirs prior to construction of Amistad Dam, it is useful to focus on a stream gage operated by the Commission, the Rio Grande at Piedras Negras, Coahuila and Eagle Pass, Texas. This stream gage has a relatively complete period of record spanning May of 1900 to present, with several gaps in the record from 1916 to 1923 for normal flows, although data has been archived for large peak flows during those years. This gaging station is located about 73.4 miles downstream from Amistad Dam and 0.5 river miles upstream from the international highway bridge between Eagle Pass, Texas and Piedras Negras, Coah. For the period before impoundment of the Rio Grande in this reach by Amistad Dam, from 1924 to 1968 the gage recorded the following:

[25] The Rio Grande Rectification Project, completed in 1938, is in the international reach of the Rio Grande and serves to stabilize the boundary line and provide flood protection to the urban areas of El Paso, Texas and Ciudad Juarez, Chihuahua.

TABLE 3 - RIO GRANDE AT EAGLE PASS, TEXAS - AVERAGE FLOW IN CUBIC FEET PER SECOND (CFS)[26]

| | | | |
|---|---|---|---|
| Daily Max: | 572,100 cfs on June 28, 1954 | Daily Min: | 30.7 cfs on June 22, 1953 |
| Monthly Max: | 48,000 cfs in Sep 1932 | Monthly Min: | 248 cfs in April 1953 |
| Yearly Max: | 9,180 cfs in 1931 | Yearly Min: | 870 cfs in 1956 |

A momentary maximum of 964,100 cubic feet per second was calculated by slope-area calculation on June 29, 1954, with a gage height of 53.51 feet for this period. Well authenticated information also indicates an occurrence of a flood with an estimated 1,236,000 cubic feet per second at a gage height of 56.0 feet. The momentary minimum occurred on June 22, 1953, with a gage height of 0.07 feet.

## 7.1 PEAK FLOWS REGISTERED IN THE VICINITY AND DOWNSTREAM OF PRESENT-DAY AMISTAD DAM

The momentary peak in 1954 was due to a dangerous and damaging flood event that occurred on the Devils and Pecos River watershed during the months of June and July of 1954. This was the greatest flood since 1865 and the second greatest since 1746 to impact Eagle Pass, Texas and Laredo, Texas and led to a number of deaths, particularly in Piedras Negras, Coahuila. At points in this vicinity, the river exceeded 3 miles in width during the peak. This flood was stopped by the recently completed Falcon Dam and Reservoir with a total of 1,850,000 acre-feet entering the reservoir from this event alone.[27]

The following historical plot depicts the flow from the 1954 flood at selected stream gages upstream of Falcon Dam. Each line is labeled with the flow peak in cubic feet per second (labeled second-feet; an outdated equivalent) and the time the peak arrived at each location.

[26] Water Bulletin Number 76 - Flow of the Rio Grande and Related Data - 2006

[27] Water Bulletin Number 24 - Flow of the Rio Grande and Related Data - 1954

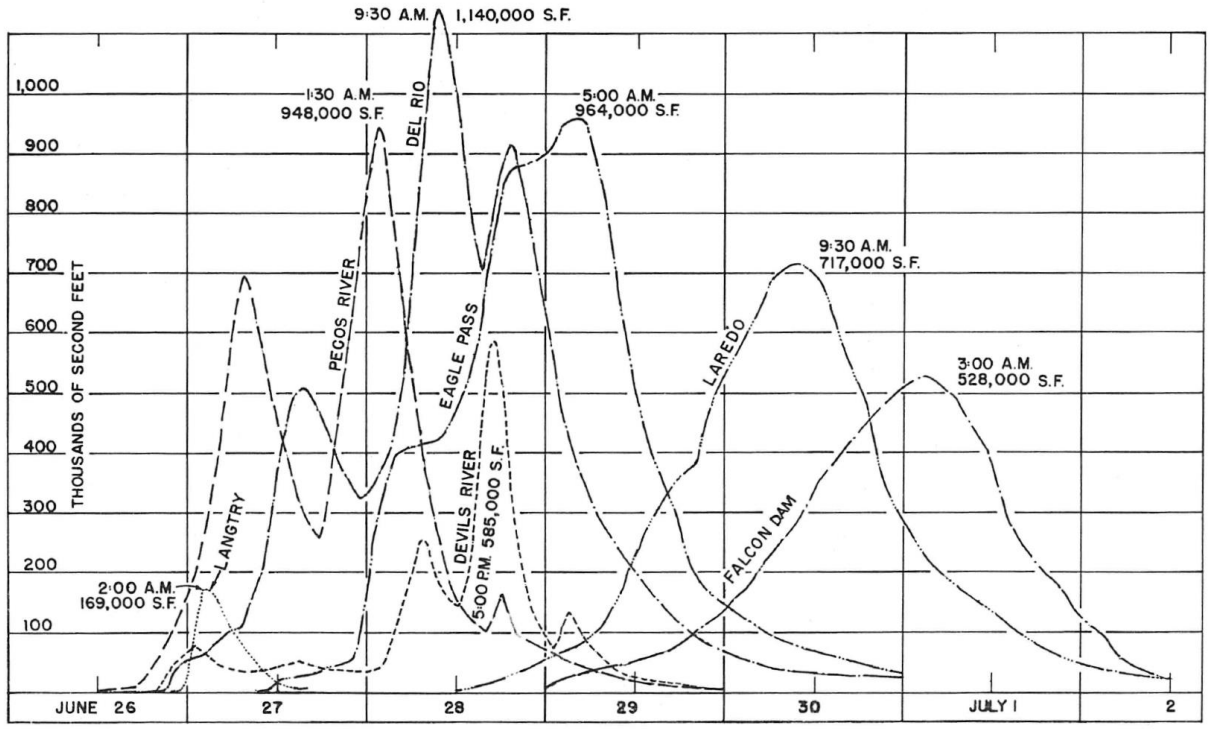


FIGURE 8 - HISTORICAL PLOT: 1954 RIO GRANDE FLOOD FLOW PEAKS (SECOND-FEET (S.F.) OR CFS)[28]

## 7.2 FLOW REGIME AT RIO GRANDE AT EAGLE PASS, TEXAS

After reviewing the flow record for the Rio Grande at Eagle Pass, Texas stream gage, it is evident that flows in the Rio Grande can vary significantly from year to year. This region of the watershed is largely fed by springs near the current site of Amistad Dam and Reservoir due to the karst geologic environment of the region, tropical systems from the Pacific and Atlantic, and the North American monsoon system which largely impacts the Rio Conchos watershed. This seasonal and annual variability of flows was an important consideration in development of the Water Treaty, the distribution of waters between the two nations, and establishing the framework for the required infrastructure to store and make beneficial use of these waters during times of surplus or drought. Prior to the Water Treaty and completion of the storage dams, significant water volumes were being sent to the Gulf of Mexico as there was no infrastructure available to capture and regulate the flood peaks and buffer the drought periods and allow continued development of the region for the various uses described previously.

[28] Water Bulletin Number 24 - Flow of the Rio Grande and Related Data - 1954

The following figures compare the flow regime and variability through the year at Eagle Pass, Texas, prior to and after construction of Amistad Dam.

The first figure shows that during the period prior to construction of Amistad Dam, the bulk of the water in this reach arrives in September and October. The driest periods occur in the spring and early summer. Peaks from April through October would have been largely driven by monsoons and tropical systems entering the basin between El Paso, Texas and Eagle Pass, Texas, including the tributaries of the Rio Conchos, Pecos, and Devils Rivers. Sustained flows through the winter and spring would have been from the springs described previously. The flood of 1954 is highlighted as this was the period maximum during this period.

The second figure shows that after construction of Amistad Dam, the stream becomes highly regulated which a much narrower operating range. Peaks are largely determined by flood releases made by Amistad Dam, and localized run-off from tributaries, arroyos, and creeks. The peak of record during this period is due to controlled flood release from Amistad Dam conducted in 2010 and is highlighted on the second plot. These flood releases were made to evacuate the flood pool due to the filling of Amistad Dam by Hurricane Alex. Minimum flows are reduced as Amistad makes year-round releases for meeting consumptive use requirements in this reach, and power generation. Springs downstream of Amistad Dam, also continue to flow into the river and provide a continuous source of water.

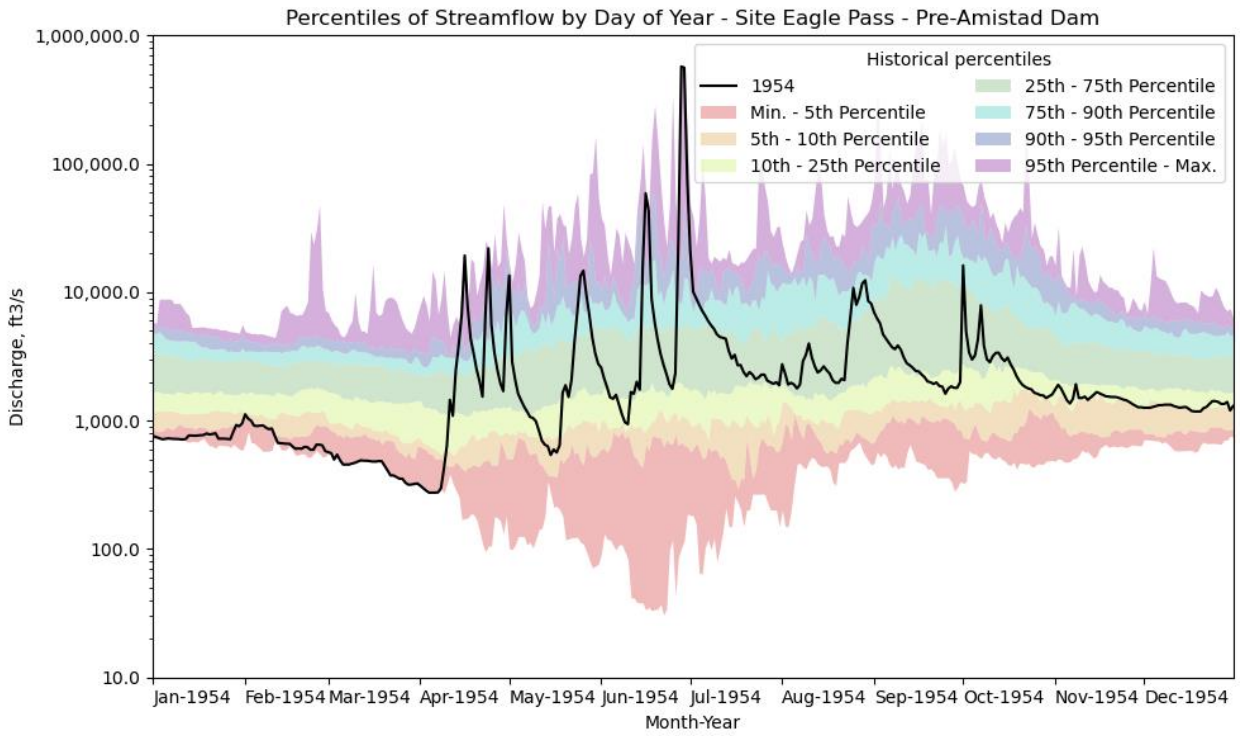


FIGURE 9 - RIO GRANDE AT EAGLE PASS: FLOW REGIME PRIOR TO CONSTRUCTION OF AMISTAD DAM

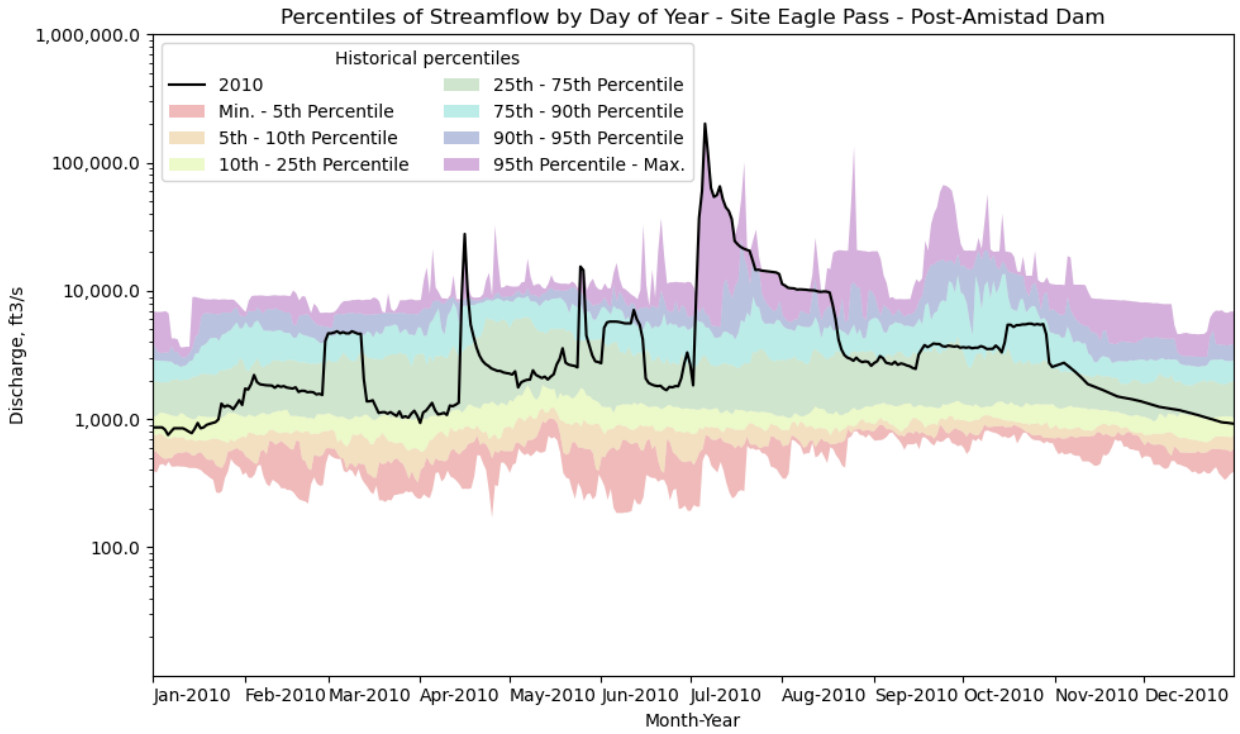


FIGURE 10 - RIO GRANDE AT EAGLE PASS: FLOW REGIME AFTER CONSTRUCTION OF AMISTAD DAM

# 8 FLOW REGIME AFTER COMPLETION OF AMISTAD INTERNATIONAL DAM

Completion of Amistad Dam drastically altered the flow regime downstream of that dam, as its storage capacity has allowed it to buffer all floods observed so far and provides a steady and constant water supply in this reach. Tributaries in this stretch have relatively small watersheds in comparison to the Devils, Pecos, and Rio Conchos basins. The largest are Arroyo El Buey, Arroyo de Las Vacas, Rio San Diego, Rio Escondido, and Rio San Rodrigo in Mexico, Pino Creek, San Felipe Creek, Sycamore Creek, Las Moras Creek, and Elm Creek in the United States. The second largest of the Mexican tributaries is Rio Salado which flows directly into Falcon Reservoir, downstream of Laredo, Texas.

## 8.1 NORMAL RELEASES FROM AMISTAD INTERNATIONAL DAM

Under normal conditions the depth of the river can vary throughout the day as releases from Amistad Dam are made in a power generating pattern, peaking with rise in energy demands, and falling at night. To meet baseflow needs for municipal withdrawals and some irrigation use, normal flows from the dam vary with the season, can average between 600 cubic feet per

second to 1,400 cubic feet per second for the day, with shorter momentary peaks up to 8,400 cubic feet per second. It is not uncommon for either country to order the movement of large volumes of water downstream to Falcon Reservoir as it has much greater consumptive use demands placed on it and is the primary water supply source for irrigation and municipal users in the lower Rio Grande in the United States and in Mexico. When feasible the power generating units will be used to convey these water requests, with average releases of up-to 8,400 cubic feet per second. It is normal for these water supply releases to last 30-60 days depending on how much water is required to meet seasonal demands from Falcon Reservoir for the Lower Rio Grande region.

## 8.2 MAVERICK DAM[29]

At river mile 542.6 a small diversion dam is located on the mainstem of the Rio Grande which allows diversion of water into Maverick Canal. The dam and canal were constructed for the Maverick County Water Control and Improvement District No. 1 (MCWCID) for irrigation and power generating purposes. Maverick Powerplant near Eagle Pass Texas began operating in 1932 and has operated almost continuously since 1937, except for periods when damaged or washed out by floods in 1932 and 1954, and a 44-day water shortage in 1953 that prevented its operation[30]. The diversion dam was constructed under the provisions of Minute No. 181, dated April 4, 1946, and Minute No. 181-A, dated July 15, 1946, which authorized the construction of a diversion dam by the MCWCID for the purposes of generating power and diverting irrigation waters into the Maverick Canal extension. Water that flows through this power plant are returned to the river at river mile 506.8, which is 10 river miles upstream of the international bridge between Eagle Pass and Piedras Negras.

[29] Commission Minute No. 181, dated April 4, 1946, "Request of Maverick County Water Control and Improvement District No. One to Construction, Operate and Maintain a Diversion Dam Across the Rio Grande about 42 Miles (67 kilometers) Upstream from Eagle Pass, Texas and Piedras Negras, Coahuila."

[30] Water Bulletin Number 76 - Flow of the Rio Grande and Related Data - 2006

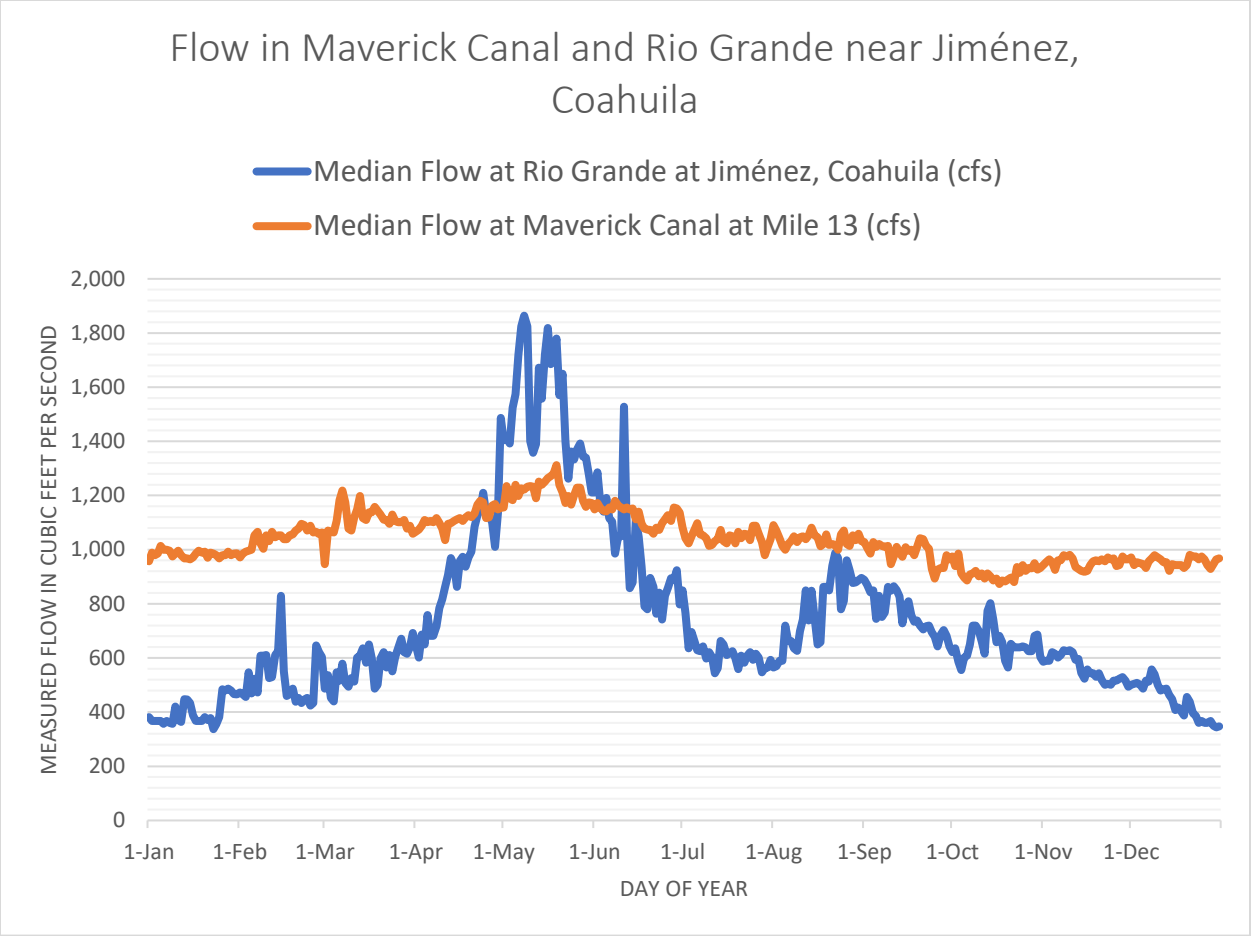


FIGURE 11 - MEDIAN FLOW COMPARISON FOR MAVERICK CANAL AND RIO GRANDE NEAR JIMÉNEZ, COAHUILA

The Maverick canal diverts up-to 1,500 cubic feet per second which can result in greatly reduced flow passing downstream. The previous plot shows the seasonal variation in flow in the Rio Grande at a Commission stream gage located near Jiménez, Coahuila, approximately 13 miles downstream of Maverick Diversion, due to the upstream diversion made into Maverick Canal. This diversion results in a greatly reduced flow in the river downstream of the diversion dam, especially during the winter. The only contributions in this reach between canal diversion and the powerplant return are Pinto Creek in the U.S. and Rio San Diego and Rio San Rodrigo tributaries in Mexico, and any local runoff from arroyos and creeks in this reach of the river. Most of the flow from Maverick Canal reenters the Rio Grande about 10 miles upstream of the city limits of Eagle Pass, Texas, after being conveyed through the canal and discharged or spilled from Maverick Powerplant. Some of the water in the canal remains for use by the irrigation district. In total this reach of the river has greatly reduced flow rates and depths for 35.8 river miles, except during run-off periods from nearby watersheds or when releases from Amistad Dam are more than about 1,000 cubic feet per second.

## 8.3 FLOOD RELEASE CRITERIA FOR AMISTAD DAM

When water levels in Amistad Dam exceed the assigned total conservation pool capacity, both Sections of the Commission are jointly responsible for coordinating and implementing the release of flood waters downstream to Falcon Reservoir[31]. In general, the rising limb of the flood hydrograph shall be scheduled so that releases will not exceed the flood discharge that would have occurred without the Amistad project, and releases from Amistad shall take into consideration the availability or storage capacity withing Amistad and Falcon reservoirs, existing forecasted weather conditions, inflows into the reservoirs, and downstream river conditions. The operating criteria for Amistad Dam are based on average three-hour inflows, calculated hourly, and the then current reservoir storage. Based on these calculations, releases are made from the dam within release bands that range from 13,000 cubic feet per second in the first release band to 1,270,000 cubic feet per second in the last depending on the rate of inflows into the reservoir and how much storage is being used at that time. In practice, the most recent flood event in 2010, due to Hurricane Alex, only reached 36,000 cubic feet per second. Operating criteria also consider the operational procedures for transitioning from one release band to the next, and once the peak reservoir storage has been reached, the shift back down through release bands back to normal flow conditions once the flood event is over.

Once the flood has passed, a temporary conservation storage may be established to provide for beneficial use of the flood waters, depending on the time of year, available storage downstream in Falcon, and other factors. Any temporary conservation storage shall be evacuated by June 1 in preparation for the hurricane season in the summer. When below conservation storage, control of the waters returns to the respective entities in the U.S. and Mexico identified previously.

## 8.4 DEPTHS AND WIDTHS IN THE EAGLE PASS, TEXAS AND PIEDRAS NEGRAS, COAHUILA REGION[32]

Inundation maps are available for the urban area between Eagle Pass, Texas and Piedras Negras, Coahuila, Mexico. These were developed through a binational project with National Weather Service (NWS) after Hurricane Alex in 2010 to provide local communities guidance on

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[31] Public Law 605, 86th Congress, approved July 7, 1960 and Minute No. 235, dated December 3, 1969, “Division of Operation and Maintenance Costs of Amistad Dam”

[32] Inundation Layers provided by National Weather Service (https://water.weather.gov/ahps2/inundation/index.php?gage=eppt2 & https://water.weather.gov/ahps/NOAA_AHPS_Guidelines_Final_2011_v3.pdf )

the extents and depths of water flows in urban areas on the border, particularly during flooding events. A hydraulic model was developed to calculate modeled depths upstream and downstream of the Rio Grande at Eagle Pass, Texas stream gage and presented as a public web product on the NWS website for the Rio Grande at Eagle Pass, Texas stream gage which redistributes the data and calculations conducted by the Commission for the purposes of flood forecasting and operational decision support. The U.S. Section worked with the NWS to provide support for this specific project and other binational inundation mapping projects that occurred on the Rio Grande.

Reviewing the results of this study shows that under non-flood conditions depths in this urban area, meaning flows contained within the normal river channel, generally do not exceed 8 feet. Reviewing operational data collected by the U.S. Section, depths during non-flood conditions, can range between 3 to 7 feet, depending on time of year, the local cross-section, and other factors. The below map shows the extents of the river in this area at a water surface elevation of 691.4 feet above msl or a gage height of 8 feet. Similarly, the subsequent plot shows the river extents and depths at 718.6 feet above msl or a gage height of 35.7 feet. This elevation is near the registered peak during Hurricane Alex in 2010 and is a useful comparison point for the range of flow seen since construction of Amistad Dam. At its deepest, a depth of about 34 feet is seen, depending on the exact cross-section of the river during these flood conditions.

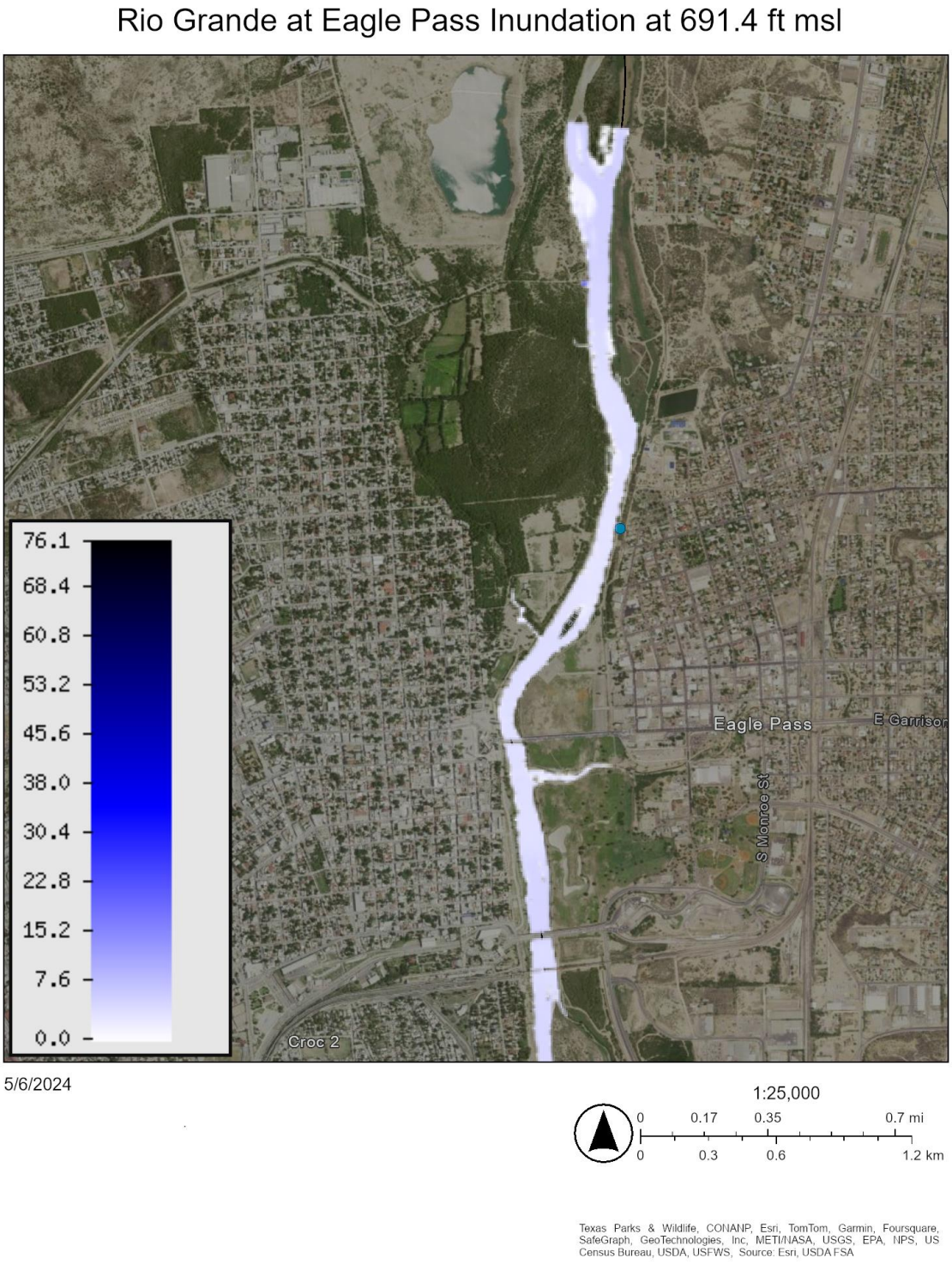



FIGURE 12 - INUNDATION MAP OF THE RIO GRANDE AT EAGLE PASS AT ELEVATION 691.4 FT MSL

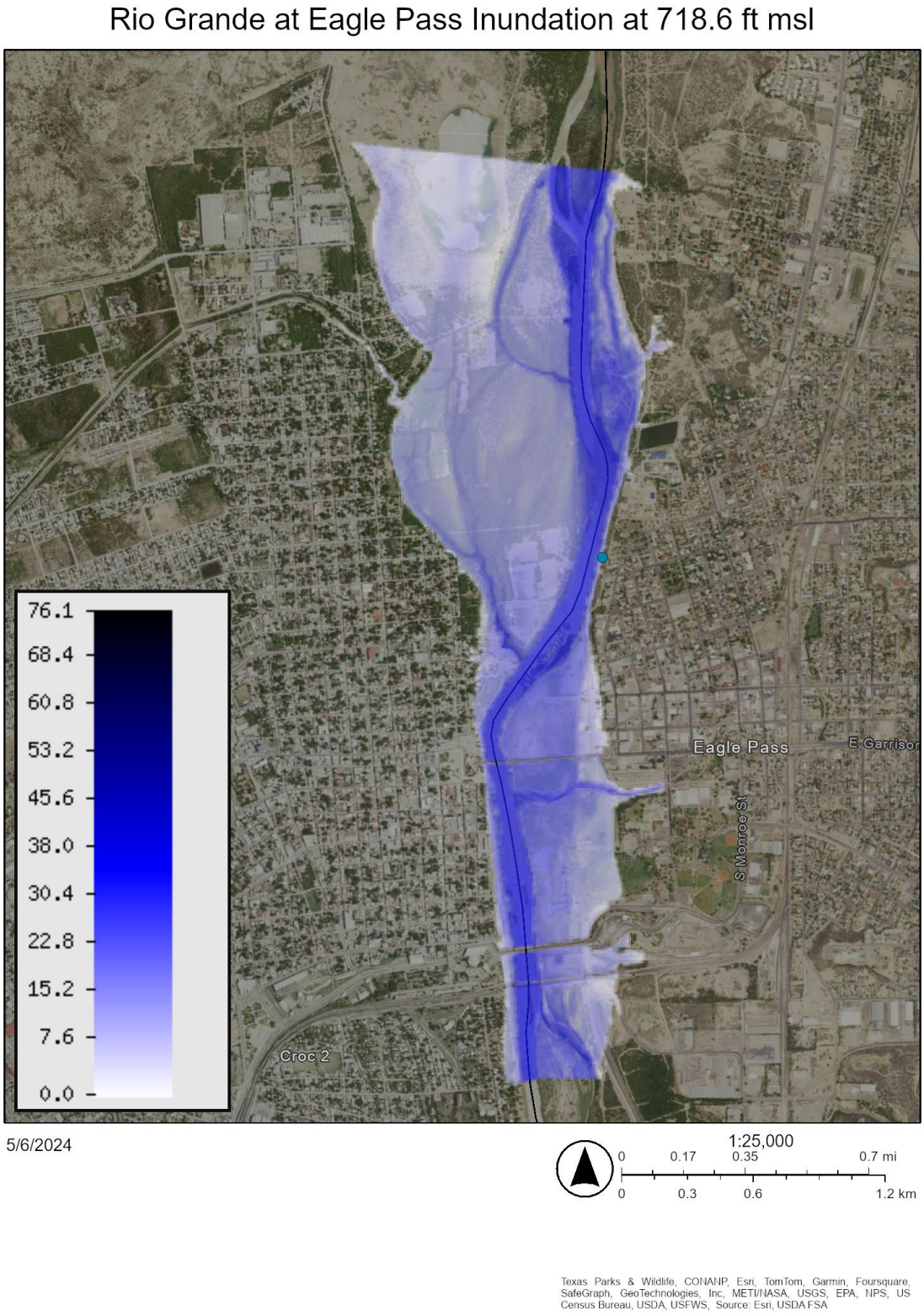



FIGURE 13 - INUNDATION MAP OF THE RIO GRANDE AT EAGLE PASS AT ELEVATION 718.6 FT MSL

## 8.5 NAVIGATIONAL USE OF THE RIO GRANDE BY THE COMMISSION IN CONDUCTING ITS MISSION

The U.S. Section deploys watercraft throughout the river boundary when water levels allow. This equipment can range from small remotely operated watercraft a couple of feet in length to larger 20'+ feet motorized watercraft. Additionally, the U.S. Section will deploy an airboat, when necessary, at various stretches of the river which can operate at even low water levels. The U.S. Section operates these watercrafts for the purposes of data collection, surveillance of infrastructure, water operations, and survey. Additionally, the Commission has partnered with other agencies and contractors, like the USGS to collect data, including under flood conditions. Data which are critical to the operations of our reservoirs highlight the critical importance of navigational access along the Rio Grande, its tributaries.

Amistad O&M boat use:

1) 16' single motor john boat, used within the spillway basin below Amistad Dam and in the reservoir itself. Used for measurements, inspections, and dam operations.

2) 26' Landing Craft boat, used on Amistad Reservoir. Used for inspections, dam operations and buoy maintenance.

Falcon O&M boat use:

3) 16' single motor john boats, used within the spillway basin below Falcon Dam and in the reservoir itself. Used for buoy maintenance, measurements, inspections, and dam operations.

4) 28' Landing Craft boat, used on Falcon Reservoir. Used for inspections, dam operations and buoy maintenance.

Mercedes and Anzalduas O&M boat use:

1) 1 - John Boat, ~8ft wide and 20ft long, use it for inspections, use it on Rio Grande and Arroyo Colorado (depth varies)

2) 1 – John Boat, ~8ft wide and 15ft long, use it for inspections, use it on Rio Grande and Arroyo Colorado (depth varies)

3) 1 – AirRanger Rhino Airboat, ~11ft wide and 30ft long, use it for inspections, use it on Rio Grande and Arroyo Colorado (depth varies)

4) 1 – 1925 Pacific Boat, ~11ft wide and 30ft long, use it for inspections, use it on Rio Grande and Arroyo Colorado (depth varies)

One of the primary and critical uses of watercraft is the collection of flow data at all operating ranges of the river from drought to flood. These data are used to calibrate models and ensure

the accuracy of Commission gaging data, as required by the Water Treaty. Commission staff are on the Rio Grande and its tributaries year-round, performing routine flow measurements as well collecting these data during weather driven flow event due to seasonal rain or tropical systems.

# 9 NAVIGATIONAL ENHANCEMENTS BETWEEN AMISTAD AND FALCON DAMS IN THE CONTEXT OF THE 1944 WATER TREATY

Article 3 of the 1944 Water Treaty establishes that the Commission may be required to make provisions for the joint use of international waters for the purposes of navigation, at the direction of the two Governments. It follows then that creation of navigation as a priority use of the waters of the Rio Grande is consistent with objectives of the 1944 Water Treaty from its inception. An amendment or modification to the general rules described in Article 8 of the Water Treaty may be required since the stretch of the river under review is between Amistad and Falcon Dam.

Under the current rules Amistad Dam is said to prioritize storage to fulfill "flood control, irrigation use and power requirements"[33] which does not consider navigation as a priority. If releases for purposes of navigation require operations inconsistent with these goals an amendment or modification to this provision, as allotted by the Treaty, would be possible, subject to approval of the two Governments.

If no alternation is required to releases and they can be made within current operating guidelines, Article 8 (f) allows either country to "avail itself, whenever it so desires, of any water belonging to it and stored in the international reservoirs, provided that the water so taken is for direct beneficial use for the storage in the other reservoirs." If Falcon has sufficient storage to capture water release from Amistad Dam, and this water is required for beneficial use by downstream users, operations could be planned to allow seasonal navigation of this stretch of the river.

# 10 CONCLUSION & STATEMENT OF EXPERT OPINION

Based on my years of experience with the U.S. Section of IBWC, my knowledge of the 1944 Water Treaty, and the facts, data, and documents I considered as outlined in this report, it is my opinion that:

[33] 1944 Water Treaty - Article 3

The flow regime of the Rio Grande has been highly modified over time. Various treaties, compacts, and agreements formed in the United States and Mexico has allocated all the waters of the Rio Grande among the users in its headwaters to the Gulf of Mexico. Storage dams have been constructed throughout the basin which serve to collect and store these waters to allow for beneficial use of these waters by irrigation districts and municipal users. The snowmelt that occurs in Colorado and New Mexico has largely been captured by storage dams constructed under the Rio Grande Compact of 1938 and Rio Grande Project, with most of these waters being captured by Elephant Butte and Caballo Dams before arriving at the international reach of the Rio Grande. Releases from these two dams are made for irrigation districts and cities. Only on rare occasions are waters from the headwaters released downstream due to flood releases.

The flow regime between Fort Quitman, Texas and the Gulf of Mexico is largely driven by seasonal monsoons and tropical systems. The construction of Amistad Dam and other smaller infrastructure like Maverick Dam have greatly modified the flow regime downstream of Del Rio, Texas, to Falcon Dam and Reservoir. The use of these water for the purpose of navigation in the reach between the two dams is highly dependent on the consumptive use needs of water users in the United States and Mexico downstream of Falcon Dam.

The Treaty allows for and recognizes navigation as a use of the water of the Rio Grande, but at present prioritizes other uses which had led to the present management practices. The two Governments can change priority of these waters and develop additional uses of the waters allotted to each, and the Water Treaty recognizes that the operating rules outlined for the international dams authorized therein, can be "…modified or amended by agreement of the Commission, with the approval of the two Governments."[34] If priorities of the current water allocations and management practices change, the Treaty was written with the required flexibility to accommodate these adjustments.

# 11 DOCUMENTS REVIEWED AND REFERENCED

- 1944 Water Treaty for the "Utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande", signed February 3, 1944, ratified November 8, 1945
- Red Bluff Reservoir - 2012 Survey Report – Texas Parks and Wildlife Department

[34] 1944 Water Treaty Article 8

- Technical Summaries of Projects Along the International Boundary – United States and Mexico – Amistad Dam Project, dated March 17, 2000
- Technical Summaries of Projects Along the International Boundary – United States and Mexico – Falcon Dam and Reservoir Project, dated March 17, 2000
- Technical Summaries of Projects Along the International Boundary – United States and Mexico – Rio Grande Rectification Project, dated March 17, 2000
- Technical Summaries of Projects Along the International Boundary – United States and Mexico – Rio Grande Canalization Project and Levee, dated March 17, 2000
- Water Bulletin Number 23 - Flow of the Rio Grande and Related Data – 1953
- Water Bulletin Number 24 - Flow of the Rio Grande and Related Data – 1954
- Water Bulletin Number 76 - Flow of the Rio Grande and Related Data – 2006
- "APPENDIX 3 – Table of River Mileages" – U.S. Section - Undated
- Commission Minute No. 181, dated April 4, 1946, "Request of Maverick County Water Control and Improvement District No. One to Construction, Operate and Maintain a Diversion Dam Across the Rio Grande about 42 Miles (67 kilometers) Upstream from Eagle Pass, Texas and Piedras Negras, Coahuila."
- Minute No. 235, dated December 3, 1969, "Division of Operation and Maintenance Costs of Amistad Dam"
- Criteria for Flood Operations – General Criteria for Flood Operations at Amistad Dam - U.S. Section
- Public Law 605, 86th Congress, approved July 7, 1960
- U.S. Section – Water Data Portal (https://waterdata.ibwc.gov/AQWebportal/)
- Inundation Layers provided by National Weather Service (https://water.weather.gov/ahps2/inundation/index.php?gage=eppt2 & https://water.weather.gov/ahps/NOAA_AHPS_Guidelines_Final_2011_v3.pdf )
- U.S. Section IBWC – Emails (8) from U.S. Section Employees

# 12 ADDITIONAL RULE 26(A)(2) DISCLOSURES

Facts and Data Considered

All facts and data considered in the drafting of this report are in the sources identified in Section 11 and/or cited elsewhere within the report.

Exhibits to Summarize or Support Facts or Opinions

All exhibits that will be used to summarize or support the facts or opinions contained in this report.

Qualifications

My qualifications are described in Section 3 and detailed in my C.V., attached here as Exhibit A.

Expert Witness Testimony over Past 4 Years

I have not testified as an expert witness at deposition or trial during the previous 4 years.

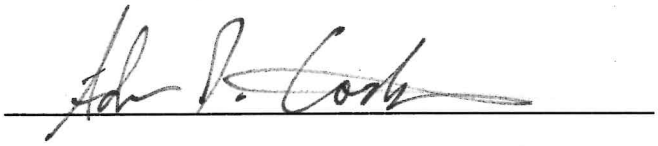
Compensation

I am an employee of the U.S. Section of the International Boundary and Water Commission and have not received compensation beyond my annual salary and benefits in preparing this report and for any future deposition or trial testimony.

# 13 SIGNATURE

I, Adrian Cortez, did consider the documents, materials, facts, and data cited in Section 11 and/or cited elsewhere in this report and reach the conclusions and opinions contained herein.

Dated: May 21, 2024



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International Boundary and Water Commission – U.S. Section